ASSESSMENT AND TREATMENT OF HAND MOUTHING: A LARGE-SCALE ANALYSIS

By

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Hand mouthing (HM) is a chronic problem in individuals with developmental disabilities. Some forms of HM are classified as self-injurious behavior when lesions, tissue breakdown, and infection occur. Although the prevalence of mouthing has been reported, data on the frequency, severity, or functions of the behavior were not included. The purpose of the present study was to conduct such an analysis of HM in a large population. The study was conducted at two public residential facilities for persons with developmental disabilities, with a total population of 830 individuals.

In Experiment I, the prevalence and risk of HM were assessed using indirect and direct observation methods. Results obtained from interviews showed that the prevalence of HM in two institutional samples was comparable to that reported in earlier studies, whereas direct observation yielded a lower estimate of prevalence. In addition, results indicated that HM, when it did occur, was likely to produce tissue damage if left untreated.

In Experiment II, modified functional analyses (FAs) were conducted, during which alone, attention, and demand sessions were alternated in multielement designs with a 2:1 ratio of alone to attention and demand sessions. Results indicated that, in 98.4% of the 64 cases for which an FA was conducted, HM was most likely maintained by automatic reinforcement.

In Experiment III, 14 individuals whose HM either occurred at very high-rates during the FA or produced severe tissue damage to the hands participated. In Phase I, a modified FA was conducted that determined participants' HM was maintained by automatic reinforcement. In Phase II, preference assessments were conducted that identified preferred leisure and/or edible items that were used during treatment. In Phase III, the following interventions were implemented in sequential order: (a) noncontingent reinforcement (NCR), (b) either NCR + differential reinforcement of alternative behavior (DRA) + response blocking or NCR + response blocking only, and (c) NCR + brief manual restraint. NCR, NCR + DRA + response blocking, NCR + response blocking, and NCR + brief restraint resulted in increases in item contact and large reductions in HM for six, five, two, and one participant(s), respectively.

INTRODUCTION

The purpose of the current investigation was to conduct a large-scale assessment and treatment of hand mouthing, a form of behavior exhibited by individuals with developmental disabilities that may or may not be injurious. In Experiment 1, the prevalence, frequency, and risk of HM were assessed using indirect and/or direct observational methods. In Experiment 2, a modified functional analysis, based on that described by Iwata et al. (1982/1994a) was conducted, to identify the extent to which participants' HM was sensitive to (maintained by) social contingencies. In Experiment 3, a progressive series of interventions was evaluated to determine which treatment, or combination of treatments, most effectively reduced HM.

Hand mouthing (HM) has been defined as the placing of one or more digits of the hand past the plane of the lips (Lockwood & Williams, 1994), insertion of the hand into the mouth beyond the first knuckle (Dorsey, Iwata, Ong, & McSween, 1980), and/or any contact between the hand and the mouth (Lerman & Iwata, 1996). Rast and Jack (1992) made a distinction between hand mouthing and the mouthing of objects, noting that the former involves contact of only the hands and the mouth, whereas the latter may include several behaviors involving contact of the mouth with other objects. HM is topographically very similar to hand biting, often making these responses indistinguishable to observers. For example, Paisey, Whitney, and Wainczak (1993) conducted a case study of a participant's self-injurious HM. Although the authors noted that the participant frequently engaged in hand biting, they only recorded instances of

HM (defined as insertion of fingers or hand into mouth). However, based on their definition, occurrences of HM may have included instances of biting. Assuming that HM and hand biting may be functionally equivalent (i.e., they are both maintained by the same environmental variable), lumping these responses together may not prove problematic. However, if the responses are maintained by different consequences, clear assessment and/or treatment outcomes may be greatly impeded. Given this, care should be taken to use definitions that allow for accurate discriminations between hand mouthing and hand biting for participants who exhibit both response forms.

HM that occurs at a high frequency and/or duration may result in injury. Researchers have reported salivary dermatitis and/or associated infections requiring medical treatment as a result of participants' HM (Ball, Campbell, & Barkemeyer, 1980; Lockwood & Williams, 1994; McClure, Moss, McPeters, & Kirkpatrick, 1986). HM has also been classified as a form of "stereotypy" because it is repetitive, has no apparent function, and may interfere with adaptive behavior (LaGrow & Repp, 1984). Regardless of whether a participant's HM is injurious, it may greatly impede her/his quality of life. Most notably, the offensive odor associated with HM may serve as a barrier to social interactions (McClure et al., 1986). In addition, mouthing may interfere with the acquisition of appropriate behaviors (Ball et al., 1980).

Prevalence

Because HM has been classified in several different ways, estimating its prevalence has been difficult. That is, some authors have described HM as a self-injurious response and have included it in studies on the prevalence of self injury (Griffin et al., 1986; Maurice & Trudel, 1982), whereas others have considered it a form of stereotypy (Bodfish et al., 1995; LaGrow & Repp, 1984). Given that studies on the

prevalence of self-injurious behavior (SIB) typically exclude noninjurious response topographies, and studies on the prevalence of noninjurious stereotypy exclude self-injurious topographies, reports on the prevalence of HM are usually incomplete.

The only study to date that has assessed the prevalence of HM specifically was conducted by Troster, Bambring, and Beelmann (1991), who surveyed parents of children (10 mo.-to-6 yr.) who were blind. Parents were asked to indicate which of 11 different stereotyped behaviors (e.g., sucking thumbs or fingers, body rocking, repetitive hand and finger movements, etc.) they had observed in their child; they were also asked to indicate the frequency of response topographies reported to occur. Results indicated that the prevalence of HM that occurred (a) at least once per week was 49.4%, (b) once per day was 36.5%, and (c) hourly was 4.7%. Although this study was the first to include HM as a specific response topography, it was conducted only with normally developing blind children; thus, the generality of these findings to adults or to individuals with developmental disabilities is unclear. In addition, the authors used only indirect (survey) methods for assessing the prevalence of SIB, stereotypy, and/or HM, which may have been unreliable or inaccurate. In the present study, we assessed the prevalence of HM by conducting a series of assessments, beginning with indirect assessments (i.e., interviews) and ending with direct observation to verify the results obtained during the indirect assessment. By conducting both indirect and direct assessments of HM, more accurate measures may be obtained with respect to prevalence.

Risk

As noted previously, HM has been reported to result in severe self-injury (Ball et al., 1980; Lockwood & Williams, 1994; McClure et al., 1986). Rast and Jack (1992)

noted that, for HM to be considered injurious, mouthing should result in "red or white hands, chapped lips or face, or lesions on the hands or face" (p. 1). In addition, they indicated that HM, when injurious, occurs both frequently and for long periods of time. Based on their definition of injury, an adequate assessment of risk should include both the frequency and severity of HM.

Few studies have assessed the frequency and/or duration of stereotypic behaviors. Dura, Mulick, and Rasnake (1987) assessed the frequency and duration of various forms of stereotypy, including rhythmic movements, bizarre posturing, self-restraint, and object manipulation. Participants' direct care staff were interviewed to determine whether or not an individual (a) engaged in each type of stereotypy and (b) engaged in the stereotypic response for 1 min, 1-to-10 min, or greater than 10 min. Although assessing the duration of HM may prove useful, it was unclear whether the duration reported was per episode, per day, or per week. If the duration was per episode, it would have been helpful to know how many episodes occurred per day. Rojahn (1986) determined the risk of participants' stereotypy by conducting a survey, consisting of a 3-point scale for severity and a 4-point scale for the frequency of occurrence. Schroeder, Schroeder, Smith, and Dalldorf (1978) used an indirect assessment to determine the severity of participants' SIB. After social workers referred individuals who exhibited SIB, a pediatrician or psychologist interviewed the social worker to assess whether the SIB was severe (it occurred at least once a day and had caused bleeding, bruises, broken bones, or other tissue damage that required intervention by a medical staff) or mild (those referrals that were not severe). The studies noted above are noteworthy in that they assessed the frequency and/or severity of several different topographies of SIB and/or stereotypy.

However, because only indirect assessments were used, the reliability of the findings is uncertain. Second, none of the studies reported data specifically on HM, making it unclear if HM often results in injury. Although authors have noted that HM may result in severe tissue damage, no studies to date have conducted a systematic assessment indicating the degree of injury associated with HM. In the present study, we sought to determine the risk of HM exclusively by conducting direct observations of the frequency and severity of participants' HM.

Function

The development of functional analysis methodology is based on over 30 years of research indicating that behavior problems (e.g., aggression, noncompliance, and SIB) are often learned performances. That is, they are maintained by contingencies of positive or negative reinforcement. Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994a) proposed a general model for assessing behavioral sensitivity to a variety of contingencies. In this study, three test conditions were used, each containing a discriminative stimulus (S^D), an establishing operation (EO), and a source of reinforcement. A fourth condition, the "play" condition, was designed to be a control. In the social disapproval or attention condition, toys were continuously available, and the therapist sat in a chair across the room reading a book. Brief attention was delivered contingent upon the target behavior, and all other responses were ignored. This condition served as a test for behavior maintained by social positive reinforcement. In the demand condition, a therapist presented instructional tasks, and problem behavior resulted in escape from these tasks. This condition tested for SIB maintained by social-negative reinforcement. In alone condition, the participant was alone in a room, and no materials were present. Persistence of responding in this condition suggested that problem

behavior was maintained by automatic reinforcement (Vaughn & Michael, 1982). During the play or control condition, leisure items were freely available, attention was delivered on a fixed-time (FT) schedule, and no demands were presented. Because both positive and negative reinforcers were noncontingently available during this condition, the probability of behavior occurring should be greatly reduced. Results showed that 4 of the 9 participants exhibited the highest levels of behavior in the alone condition, suggesting their self-injury was maintained by automatic reinforcement, and 3 participants exhibited undifferentiated responding or responding that was high across all conditions, suggesting their behavior may also have been maintained by automatic reinforcement. Two participants exhibited the highest levels of SIB during demand sessions, suggesting their behavior was maintained by social-negative reinforcement, and only 1 participant exhibited differentially highest levels of self-injury during attention sessions, suggesting his behavior was maintained by access to attention.

Although functional analysis provides information for effective treatment development, few researchers have conducted functional analyses prior to treatment selection for HM (e.g., Mazaleski, Iwata, Rodgers, & Zarcone, 1994; Vollmer, Marcus, & LeBlanc, 1994; Lerman & Iwata, 1996). In addition, out of the studies that have included a functional analysis prior to treatment, small sample sizes were used, limiting the generality of their findings. The study with the largest sample size to date was conducted by Goh et al. (1995), who conducted functional analyses of 12 individuals who exhibited HM. Results indicated that in 10 of the 12 participants' (83%) HM was either (a) higher in the alone condition relative to the other test conditions or (b) not differentially high during either the attention or demand conditions. Thus, in a large majority of the cases,

HM persisted in the alone condition and was insensitive to social contingencies, indicating the behavior was maintained by automatic reinforcement. However, whether these data reflect the proportion of HM that is maintained by automatic reinforcement in the larger population of individuals who engage in the behavior remains unclear.

Although functional analysis methodology has been used by many researchers to identify the maintaining variables of a wide range of behavior disorders, several authors have noted that this assessment may be too time consuming (Durand & Crimmins, 1988; Repp, Singh, Olinger, & Olson, 1990). For example, in a large-scale study based on 152 functional analyses, Iwata et al. (1994b) reported that the duration of assessment ranged from 8 to 66 sessions (2 hr to 16.5 hr). In the study noted above by Goh et al. (1995), functional analyses averaged 25 sessions (6 hours).

A number of procedural variations have been designed to increase the efficiency with which functional analyses can be conducted. One such variation is the "brief functional analysis" (Cooper et al. 1992; Derby et al., 1992; Northup et al., 1991; Wacker et al., 1990). Derby et al. assessed the effectiveness of the brief functional analysis for 79 participants. Each participant was evaluated during a 90-min period, and results showed that the target behavior was observed and clear differentiation in the data patterns emerged for 46.6% of the participants. In a more direct evaluation of the brief functional analysis, Kahng and Iwata (1999) compared the outcomes from 50 functional analyses consisting of brief (single) and extended exposures to test and control conditions and found that interpretations from the brief and extended analyses matched for 66% of the individuals. The development of the brief functional analysis has been a significant contribution to the field of behavior analysis by offering an efficient and objective

assessment method for use under time constraints. However, some limitations of the brief functional analysis are that single exposures to test conditions may be insufficient to occasion behavior or to establish discrimination among contingencies associated with the different conditions.

Another method for increasing the efficiency of functional analyses is to shorten session length. This procedural variation would decrease the overall length of assessment while permitting repeated exposures to each test condition. Wallace and Iwata (1999) compared the results obtained from functional analyses based on varying session durations (i.e., 15 min, 10 min, and 5 min). Functional analyses involving attention, demand, alone, tangible, and play conditions were conducted in multielement designs. Forty-six functional analyses based on 15-min sessions were used to generate shorter data sets by subtracting the last 5 min (for the 10-min duration) and the last 10 min (for the 5-min duration) from each session, allowing for comparisons among 15-, 10-, and 5-min session durations. Evaluators who were blind to participant identity and session duration visually inspected the graphs to determine whether the results indicated attention, tangible, escape, and/or automatic functions. The authors then determined the extent to which the interpretations based on each 15-min data set matched those based on 10- or 5-min data sets. Results indicated perfect agreement for comparisons between the 15- and 10-min session durations and only three disagreements for comparisons between 15- and 5-min session durations. The mean durations of the 15-, 10-, and 5-min functional analyses would have been 6.1 hr, 4.1 hr, and 2.1 hr, respectively. Based on these findings, 5-min sessions often may be sufficient to reveal functional relationships and

may greatly reduce the amount of time required to conduct assessments involving repeated exposure to test conditions.

Another method for increasing the efficiency of functional analyses involves progressing from a brief functional analysis to a more extended analysis if needed. Vollmer, Marcus, Ringdahl, and Roane (1995) developed a model for conducting functional analyses using conditions that were based on those described by Iwata et al. (1982/1994a). In this model, a brief functional analysis was first conducted (Phase I); if differentiated results were obtained, the assessment was complete. If differentiated results were not obtained, a more extended multielement format was used (Phase II). If differentiated results were observed in the more extended analysis, the assessment was complete. If undifferentiated results occurred, an extended no-interaction condition was conducted to determine whether behavior persisted in the absence of social contingencies (Phase III). If behavior occurred at high levels during this condition, the assessment was complete; if behavior extinguished during the extended no-interaction condition, indicating that behavior may be sensitive to social reinforcement, the functional analysis conditions were presented in a reversal design (Phase IV). The function of participants' problem behavior was identified for 17 of the 20 participants as a result of this methodology.

The development and continued research on methods for increasing the efficiency of functional analysis methods is important because it provides clinicians working under time constraints with a more objective alternative to indirect methods. In the present study, we assessed the utility of an abbreviated functional analysis methodology. Because previous research indicates that HM is often maintained by automatic

reinforcement, we conducted a series of alone sessions that were interspersed with attention and demand probes. If behavior persisted during the alone condition, with lower levels in the attention and demand conditions, this would verify our hypothesis that the participant's HM was maintained by automatic reinforcement. If responding did not persist during the alone condition, then a more extended functional analysis would be conducted until a clear function could be identified.

Interventions for Stereotypy and/or Behavior Maintained by Automatic Reinforcement

If results of a functional analysis verify that HM is maintained by automatic reinforcement, procedures that have been found effective in reducing problem behavior maintained by automatic reinforcement comprise the treatments of choice. One such procedure is noncontingent reinforcement (NCR). For example, Goh et al. (1995) presented leisure items to participants who exhibited HM maintained by automatic reinforcement. Results indicated that NCR resulted in reduced levels of hand mouthing and high levels of item manipulation for 3 of the 4 participants. These findings suggested that stimulation from the leisure items might have substituted for the stimulation from participants' HM. Shore et al. (1997) demonstrated the effectiveness of NCR in three individuals who exhibited SIB in the form of arm rubbing (1 participant) or hand mouthing (2 participants). Functional analyses indicated that SIB occurred most often in the absence of social contingencies (i.e., the alone condition), suggesting participants' SIB was maintained by automatic reinforcement. During baseline, when no interaction or materials were delivered, SIB occurred at moderate-to-high levels; during NCR, when preferred stimuli (based on a stimulus preference assessment) were continuously available, SIB was greatly reduced, and item contact occurred at high levels. These

findings also suggested that the stimulation from the leisure items may have competed with that produced by participants' SIB. A noteworthy feature of both the Goh et al. and Shore et al. studies is that the authors conducted a functional analysis prior to evaluating treatment. It is important to empirically demonstrate whether problem behavior is maintained by automatic reinforcement. Without appropriately ruling out potential social reinforcers that may be maintaining responding, treatment procedures may have limited effectiveness.

In other studies, supplementary procedures, such as differential reinforcement of alternative behavior (DRA) and/or prompting, have been used to decrease stereotypy and increase object manipulation. Favell, McGimsey, and Schell (1982) found that DRA effectively reduced participants' problem behaviors (HM, eye poking, and/or pica) and increased appropriate item manipulation. After NCR was found ineffective in suppressing HM to low levels and increasing adaptive behaviors (e.g., appropriate social interaction and item interaction) to high levels, Horner (1980) assessed the effectiveness of DRA and observed further decreases in SIB and increases in adaptive behaviors. Singh and Millichamp (1987) evaluated the effectiveness of prompting to teach individuals with profound mental retardation to engage in appropriate play and social behaviors. Results indicated that stereotypy and inappropriate play behaviors decreased to low levels when appropriate behaviors increased.

When reinforcement-based interventions, such as NCR and DRA, do not result in concomitant decreases in problem behaviors, interventions aimed at directly reducing problem behaviors, such as response blocking and manual restraint, have been used. Lerman and Iwata (1996) assessed the effects of response blocking on one participant's

HM that was maintained by automatic reinforcement. Baseline and response blocking sessions were conducted in a reversal design. Baseline sessions were identical to the alone condition of the functional analysis in that no interaction was delivered. During response blocking sessions, the therapist manually blocked some or all attempts at HM. Results indicated that when HM was blocked, HM attempts decreased to near-zero levels. Lindberg, Iwata, and Kahng (1999) assessed the effectiveness of response blocking with two individuals who exhibited several different topographies of SIB (head or body hitting, rubbing, finger pressing against face). Results of a functional analysis indicated that their behavior was not maintained by social reinforcement. The authors implemented a progressive series of treatment components (NCR, NCR with prompting, NCR and DRA with prompting, NCR and DRA with prompting and response blocking) in a multiple baseline design. During NCR, when preferred leisure items were continuously available, moderate-to-high levels of SIB occurred, and little or no item contact occurred. Similar findings were obtained during the NCR with prompting condition. During NCR and DRA with prompting, when food items were delivered contingent upon specified durations of independent item contact, SIB continued to occur at high levels, and item contact did not increase. When the response-blocking component was added to the other treatments, item contact did not increase; however, HM did decrease for one of the two participants. The studies noted above lend some support for the efficacy of response blocking in reducing HM and other forms of stereotypy.

Turner, Realon, Irvin, and Robinson (1996) assessed the effectiveness of brief manual restraint in three individuals with profound mental retardation. Results of a functional analysis indicated that participants' HM was not maintained by social

reinforcement. NCR and NCR with restraint sessions were conducted in a reversal design. During NCR, when leisure items were continuously available, HM occurred at high levels, and item contact occurred at low levels; during NCR with restraint, when the therapist placed the participant's hand in her/his lap for 3 s following each HM attempt, HM decreased to low levels, and item contact increased to high levels. Thompson, Iwata, Conners, and Roscoe (1999) demonstrated the importance of including preferred items when using manual restraint procedures. After conducting a functional analysis of participants' SIB (hand mouthing, head and body hitting) to rule out behavioral maintenance by social contingencies, an assessment was conducted to identify participants' preferred leisure items. Next, the effects of brief manual restraint were evaluated in reversal or multiple baseline designs. During baseline and manual restraint conditions, participants were also exposed to reinforcement and no-reinforcement conditions, which were alternated in a multielement design. Baseline sessions were identical to the no-interaction condition (the therapist did not use manual restraint during this condition) of the functional analysis. During manual restraint sessions, the therapist held a participant's hands in her/his lap or across her/his chest for 15 s contingent upon SIB attempts. During no-reinforcement sessions, the participant did not have access to leisure items; during reinforcement sessions, participants had continuous access to their top preferred leisure item identified in the preference assessment. Results indicated that although manual restraint with no reinforcement resulted in decreases of participants' problem behavior, manual restraint was more effective when combined with reinforcement. These findings lend support for the use of manual restraint when reinforcement-based interventions prove ineffective. In addition, the findings of

Thompson et al. demonstrate the importance of including preferred leisure items when using more intrusive interventions, such as manual restraint.

In summary, a number of treatment procedures, ranging from benign interventions such as NCR to more intensive ones such as restraint, have been found effective in suppressing problem behavior maintained by automatic reinforcement. However, there are some limitations of research on the treatment of HM. First, few of these studies have focused on HM specifically, making it unclear whether procedures found effective with other response topographies would also prove effective for HM. Second, treatment procedures have often been implemented without first conducting a functional analysis. Although research indicates that stereotypy often persists in the absence of social contingencies (Lindberg et al., 1999), it is important to conduct functional analyses to rule out a potential social function. Third, researchers often did not use systematic preference assessments prior to implementing NCR and DRA treatment components. Because the reinforcer for behavior maintained by automatic reinforcement is unknown, it is important to identify potent reinforcers that may effectively compete with the sensory stimulation the problem behavior produces. Finally, researchers have often used intrusive interventions, such as restraint and protective equipment, without first assessing the effectiveness of reinforcement-based interventions. The present study attempted to extend current research on the treatment of HM and behavior maintained by automatic reinforcement in the following ways: (a) A functional analysis was conducted to rule out behavioral sensitivity to social contingencies, (b) systematic preference assessments were conducted to identify preferred leisure materials that may compete with HM and to identify edible items that may reinforce appropriate play behaviors, (c) a progressive

series of interventions was used, beginning with NCR and gradually introducing more intrusive components such as response blocking and brief manual restrain on an as needed basis.

STUDY 1: PREVALENCE AND RISK OF HAND MOUTHING

Method

Participants

All individuals living in two state residential facilities for persons with developmental disabilities, one in Florida (N=501) and one in Tennessee (N=329), participated in the initial screening (see below). Participants' ages ranged from 16 to 55 years, their levels of mental retardation ranged from mild to profound, and their verbal skills were extremely variable but generally very limited. All 830 or some subset of these individuals participated in the procedures noted below.

Response Definition

During all assessment procedures, HM was defined as placement of the hand past the plane of the lips or as repetitive contact between the hand and the mouth. In addition, staff members were told that participants' HM should be repetitive and chronic to be included (to exclude socially acceptable forms of HM, such as when eating).

Indirect Assessment

During the initial screening, Behavior analysts and/or direct care staff from each home at both residential facilities were contacted through email or telephone and were asked to identify individuals in their home who exhibited HM. At the institution in Florida, staff members were given a list of names and asked to indicate whether or not each participant exhibited HM. At the institution in Florida, Behavior analysts who worked closely with the clients were asked to list the names of individuals who exhibit

HM. As a result of this initial screening, 130 participants were reported to engage in HM. These 130 individuals participated (see Table 1 for their demographic information) in all subsequent assessments unless otherwise noted. The proportion of the participant

Table 1
Demographic Characteristics of Participant Sample (N=130)

	Number	Percentage
Sex		
Male	75	57.7%
Female	55	42.3%
Age		
1-10	0	0.0%
11-20	3	2.3%
21-30	21	16.2%
31-40	37	28.5%
41-50	49	37.7%
51+	20	15.4%
Degree of retardation		
Mild/moderate	4	3.1%
severe	2	1.5%
profound	124	95.4%
Impairments		
visual	43	33.1%
auditory	38	29.2%
physical	47	36.2%
Receptive verbal skills		
none	15	11.5%
minimal	69	53.1%
follows directions	46	35.4%
Expressive verbal skills		
none	103	79.2%
minimal	4	3.1%
one-word utterances	9	6.9%
Two-to-ten-word utterances	8	6.2%
>10 word utterances	6	4.6%

sample classified as having profound mental retardation was very high (95.4%) and not representative of the total population of 830.

Following the initial screening, more extensive interviews were conducted to gather information about the 130 individuals identified. A graduate student met with a staff member who worked with the participant in an office or a quiet room and asked the staff member specifically whether or not a participant exhibited HM. If HM was reported to occur, the interviewer also asked staff to estimate whether HM occurred at a low rate (less than once per hour) or at a higher rate (more than once per hour). Interobserver agreement was not assessed for these indirect assessments.

Direct Assessment

Direct observations were conducted for two purposes. First, we wanted to verify results of the interviews by observing whether a participant reported to engage in HM actually did so. Second, we wanted to determine whether participants engaged in high or low rates of HM. Because HM that occurs at higher frequencies may be more likely to result in injury, this measure provided information related to the risk of participants' HM.

One hundred and two of the 130 individuals reported to engage in HM during the indirect assessment participated. We were unable to obtain consent for 28 of the individuals. Sessions were conducted in therapy rooms located in a clinic for the assessment and treatment of SIB, or were conducted in quiet rooms in participants' homes. If participants wore protective equipment, the equipment was removed prior to conducting observations.

Trained observers recorded instances of HM using either handheld computers (Assistant model AST 102) or a data sheet segmented into 10-s bins. Sessions were either 5 or 10 min, and the total observation was 60 min. Data were summarized as the

percentage of 10-s intervals during which HM occurred. Reliability was assessed by having a second observer collect data independently during an average of 34.2% of the sessions. Observers' records were compared on an interval-by-interval basis, and percentage agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. The mean percent agreement was 96% (range, 91.1% to 97.7%).

The majority of sessions resembled the alone condition of the functional analysis (i.e., individuals had no materials, and no interaction was provided). Also, to rule out the possibility that HM may not occur during an alone condition as a result of behavioral maintenance by social contingencies, at least one attention and at least one demand condition were conducted (see below, functional analysis). By directly observing participants under these conditions, we increased the likelihood that low rates or an absence of responding during no interaction conditions were not the result of extinction. Information regarding whether or not HM occurred during the direct assessment was used to determine the accuracy of the indirect assessment. Information regarding the amount of HM that occurred during the assessment provided information concerning the risk of HM. For example, individuals who exhibited HM during less than 20% of the intervals were classified as having low-rate HM, whereas individuals who exhibited HM during 20% or more of the intervals were classified as having high-rate HM.

Severity

The 130 participants reported to engage in HM during the interview participated. The settings were identical to those used for the direct assessment.

During the severity assessment, either a behavior analyst or a graduate student examined a participant's hands and rated the extent of injury on a 4-point scale according

to the following criteria: (a) A "1" was scored if no cuts, bruises, or swelling were observed; (b) a "2" was scored if reddened areas, but no cuts, bruises, or swelling were present; (c) a "3" was scored if there was current injury, such as scabs, swelling, or cracks; and (d) a "4" was scored if the participant wore protective equipment prescribed to prevent HM. HM was classified as injurious if a score of a 3 or a 4 was recorded.

A second observer collected data independently on an average of 54.6% of these assessments. In comparing observers' records, an agreement was defined as both observers having recorded the same score for a given participant. Interobserver agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%. The mean percentage agreement across participants was 91.5% (range, 0% to 100%).

Results and Discussion

Table 2 shows the results from the indirect assessment. Out of the entire population (830 individuals), 130 (15.7%) were reported by staff to engage in HM, and 59 (7.1%) were reported to engage in high-rate HM (greater than once per hour). Although the reported prevalence of HM was much less than that reported by Troster et al. (1991), instances of high rate HM were comparable to those reported by Troster et al.

Out of the 130 individuals reported to engage in HM, direct observations were conducted for 102. To estimate the number of individuals who exhibited HM out of the larger sample size (n = 130), we first determined the proportion of individuals who were observed to exhibit HM out of the smaller sample (n = 102). Sixty-four out of the 102 or 62.7% were observed to engage in HM. Thus, the estimated number of individuals who exhibited HM out of the larger sample of 130 was 62.7% or 82. Out of the total population of 830 individuals, the estimated number that engaged in HM was 82 or 9.9%.

We used the same method to estimate the number of individuals who engaged in high-rate HM (50 or 6% of the total population of 830). The percentage of high rate HM, given that HM was observed, was 61%. Thus, results obtained from direct observation yielded lower figures than those obtained from the indirect assessment for overall prevalence as well as for prevalence of high-rate HM. These findings also suggest that the majority of individuals who exhibit HM engage in this behavior at a high rate.

Table 2
Experiment I: Prevalence, Frequency, and Severity Results

	Number	Proportion
Indirect Assessment (N=830)		
Overall prevalence	130/830	15.7%
High rate HM	59/830	7.1%
Direct Observation (N=130*)		
Overall prevalence	82/830	9.9%
High rate HM	50/830	6.0%
High rate HM/All observed HM	50/82	61.0%
Severity Ratings (N=130)		
Overall prevalence of severe HM	29/830	3.5%
Severe HM/All observed HM	29/82	35.4%

* Numbers reflect estimates for the 130 individuals reported to engage in HM based on direct observation of 102 of these individuals.

All 130 individuals reported to engage in HM received a severity measure through direct observation. Twenty-nine individuals or 3.5% of the total population (830) were observed to have severe HM (i.e., a 3 or a 4 severity score). The proportion of individuals who engaged in severe HM (HM that produced observable tissue damage or required protective equipment to prevent such damage), given that HM was observed, was 35.4%.

A strength of this investigation was that both interview and direct observation methods were used to determine the prevalence of HM. Results of a recent study by

McGill, Hughes, Teer, and Rye (2001) indicate a high degree of variability obtained through indirect assessment methods. After conducting interviews with staff members regarding the occurrence and frequency of various topographies of problem behavior, the authors found large differences in the frequency of behaviors reported by staff members. It is interesting to note that larger differences were obtained for stereotypic behavior and for higher-frequency problem behavior. Given that HM may be a form of stereotypy and/or a high-frequency topography, direct observations seems particularly warranted.

A weakness of the present experiment was that we did not check false negatives. That is, it is possible that a greater number of individuals than those actually reported exhibited HM. Future research could assess false negatives by conducting direct observations with some proportion of the individuals not reported to engage in HM to verify the absence of HM.

EXPERIMENT 2: FUNCTIONAL ANALYSIS OF HAND MOUTHING

Method

Participants and Setting

All individuals who were directly observed to engage in HM (N=64) during Experiment 1 participated in Experiment 2. Observations were conducted in a quiet room in the individual's home or at a day program for the assessment and treatment of their problem behaviors.

Data Collection and Reliability

HM was defined as either contact between the hand/fingers and the mouth or insertion of the fingers past the plane of the lips. Trained observers recorded the presence or absence of HM during continuous 10-s intervals, using a pencil and scoring sheet or a hand-held computer (Assistant model AST 102). Data were summarized as the percentage of intervals during which HM occurred. Interobserver agreement was assessed during a mean of 32% of the sessions. Percentage agreement scores were calculated based on an interval-by interval comparison of the observers' records by dividing the number of agreements by the total number of intervals and multiplying by 100%. Mean agreement was 95.6% (range, 90.1% to 98.9%).

Functional Analysis

Procedures based on those described by Iwata et al. (1982/1994a) were conducted to identify the functional properties of HM and were modified in several ways to increase the efficiency of assessment. First, in light of data reported by Wallace and Iwata (1999)

indicating that results from 5- or 10-min sessions generally correspond to those obtained from 15-min sessions, all functional analysis sessions were either 5- or 10-min in duration. In addition, based on the Goh et al. (1995) findings, which suggested that HM is unlikely to be maintained by social contingencies, the functional analysis was designed primarily to determine whether HM persisted in the absence of social consequences, while still providing some exposure to social contingencies. More specifically, participants were initially exposed only to attention, demand, and alone sessions. Conditions were alternated in a multielement design with a 2:1 ratio of alone to attention/demand sessions. If results were clear after 14 sessions (10 alone, two attention, and two demand sessions), assessment was terminated. However, if results were unclear, assessment was extended until a clear function emerged. The specific conditions extended depended upon the pattern of responding obtained during the initial 14-session assessment. For example, if results were undifferentiated, with slightly lower levels of HM in the alone condition relative to the demand condition, alone and demand conditions were extended and alternated in a 1:1 ratio. However, if results were undifferentiated, with slightly lower levels of HM in the alone condition relative to attention and demand conditions, then an extended multielement functional analysis (including alone, attention, play, and demand conditions) was conducted.

Results and Discussion

Figure 1 shows results of the functional analysis for 3 participants. Each participant represents a pattern of responding typically observed. In the first pattern, HM occurred at high levels only in the alone condition, with much lower levels occurring during the attention and demand conditions (top panel). Out of 64 individuals, 17 or 26.6% exhibited responding characteristic of this pattern. In the second pattern, a high

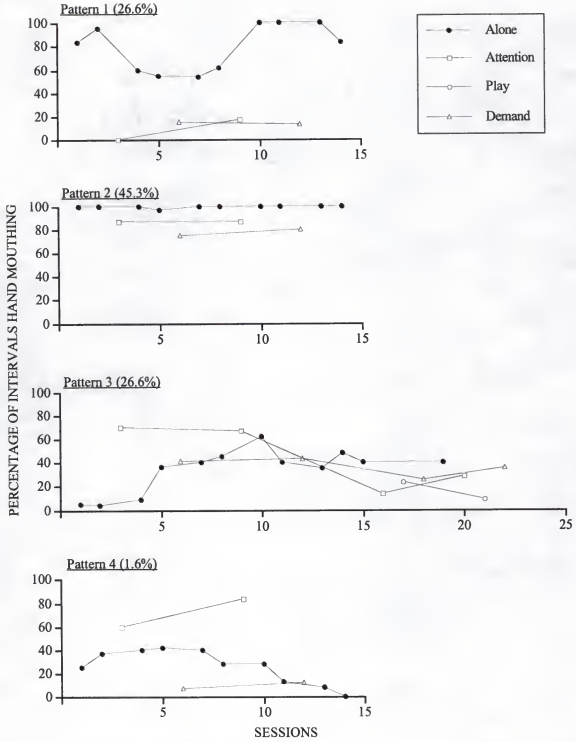

Figure 1: Percentage of intervals hand mouthing during functional analysis sessions. The top graph depicts pattern 1, the second from top graph depicts pattern 2, the second from the bottom graph depicts pattern 3, and the bottom graph depicts pattern 4. See text for details

level of responding occurred across conditions, with slightly lower levels in the attention and demand conditions (second panel). Out of 64 participants, 29 or 45.3% exhibited responding characteristic of this pattern. In the third pattern, HM occurred during all conditions but was not differentially high during any condition (third panel). Out of 64 participants, 17 or 26.6% exhibited responding characteristic of this pattern. As noted previously, when this pattern was observed, either a series of extended alone sessions or 1:1 alternating sessions continued until a clear and differentiated pattern emerged. Results for all individuals who received an extended analysis indicated that their HM was either higher in the alone condition or not differentially high during attention and demand conditions. A fourth pattern of responding was observed in one participant, in which HM occurred at high levels during the attention condition, with much lower levels occurring during the alone and demand conditions (see bottom panel of Figure 1), indicating that the behavior was maintained by social positive reinforcement in the form of attention. In summary, 63 of 64 or 98.4% of the functional analyses revealed patterns indicating participants' HM was maintained by automatic reinforcement.

In Experiment 2, we used an abbreviated functional analysis design whose modifications were based on previous research. We hypothesized that the participants' HM was most likely maintained by automatic reinforcement, and, as a result, conducted alone sessions primarily, which were interspersed with attention and demand sessions. This design proved useful in identifying a behavioral function for all participants in a relatively brief amount of time.

The functional analysis method used in this study extends previous research on brief functional analyses. Vollmer, Marcus, Ringdahl, and Roane (1995) assessed the

effectiveness of a brief functional analysis in which 2-to-3 sessions were conducted for each condition, and within-session response patterns were analyzed for each of the sessions to determine function. Assessments took 1 to 2 hr, and 30% of the assessments yielded differentiated results during this brief analysis. The present study differs from that used by Vollmer et al. in that we used repeated measures of responding in all conditions with proportionally more alone sessions relative to attention and demand sessions. However, the total duration of the 14-session assessment used in the present study was comparable to that reported by Vollmer et al. (1 hr 10 min when sessions were 5-min; 2 hr 20 min when sessions were 10-min). In addition, the 14-session assessment yielded differentiated results for 47 of the 64 (or 73.4%).

Hanley, Iwata, and Thompson (2001) used another procedural variation when conducting functional analyses. In their analysis, two conditions were compared: A test condition (either attention or tangible), in which a suspected reinforcer was delivered contingent upon problem behavior, and a control condition, in which the same reinforcer was available noncontingently. There are several noteworthy features of the authors' procedural variation of the typical functional analysis method. First, the method was very efficient (taking under 2 hours to implement). Second, the assessment allowed for repeated measures of the test condition assessed. Third, the specific test condition used was based on reports from staff and results from structured observations. Fourth, all participants were successfully treated by interventions based on the results of their functional analyses. Our method extended the Hanley et al. method by (a) testing for automatic reinforcement primarily and (b) by conducting probes of all test conditions to rule out behavioral maintenance by social reinforcement.

A potential limitation of our method was our selective use of test conditions. Including a relatively small number of attention and demand sessions may have limited the sensitivity of the analysis in detecting social reinforcement functions. Future research could compare results obtained through the modified design used in this study with results obtained by the more extended design used by Iwata et al. (1982/1994a).

EXPERIMENT 3: TREATMENT

Data from Experiment 2 indicated that the HM is most often maintained by automatic reinforcement. Based on this information, treatments that have been found effective for behavior maintained by automatic reinforcement are perhaps most appropriate for HM.

Various interventions for behavior maintained by automatic reinforcement have been applied to HM. For example, NCR, DRA, response blocking, and manual restraint have been shown to effectively suppress HM. However, few studies have examined these procedures in the context of functional analyses and systematic preference assessments. In addition, the literature on treatment for HM contains mostly small N studies and few comparative analyses of various treatment components. Furthermore, no study to date has conducted a progressive series of interventions on a large number of participants exhibiting HM.

The purpose of this experiment was to evaluate and compare a series of interventions for HM maintained by automatic reinforcement and to implement the interventions in a manner progressing from least to most intrusive. To this end, three different phases were conducted during Experiment 3. First, functional analyses were conducted for all participants to rule out behavioral sensitivity to social reinforcement. Second, systematic preference assessments were conducted to identify preferred leisure items that may compete with HM and preferred food items that may be used as reinforcers to increase item manipulation. Third, we sought to evaluate the utility of a

progressive series of interventions, focusing on the least restrictive procedure necessary for effectively reducing HM and increasing item contact.

Participants and Setting

Out of the 29 individuals whose HM was observed to be either severe or severe and high-rate during Experiment 1, 14 participated in the treatment study. These 14 participants were selected because they specifically had been referred for assessment and treatment, making them high priority cases, or because they did not have scheduled activities that conflicted with sessions.

Data Collection and Reliability

As in Experiments 1 and 2, HM was defined as either placement of the hand past the plane of the lips or as repetitive contact between the hand and the mouth. Trained observers recorded instances of HM using either handheld computers (Assistant model AST 102) or a data sheet segmented into 10-s bins. Data was summarized as the percentage of intervals during which HM occurred. Reliability was calculated by having a second observer collect data independently on an average of 31.2% of the sessions. Observers' records were compared on an interval-by-interval basis, and percentage agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. The mean percent agreement for HM was 95.3% (range, 87.4% to 100%).

Phase I: Functional Analysis

Because all participants received a functional analysis in the previous study, we did not conduct another functional analysis. Functional analyses from experiment 2 for individuals participating in experiment 3 are shown in Figure 2. Deanna, Gina, Dan, Ted, Andy, and Beth (top 2 rows) exhibited high levels of HM during the alone condition and

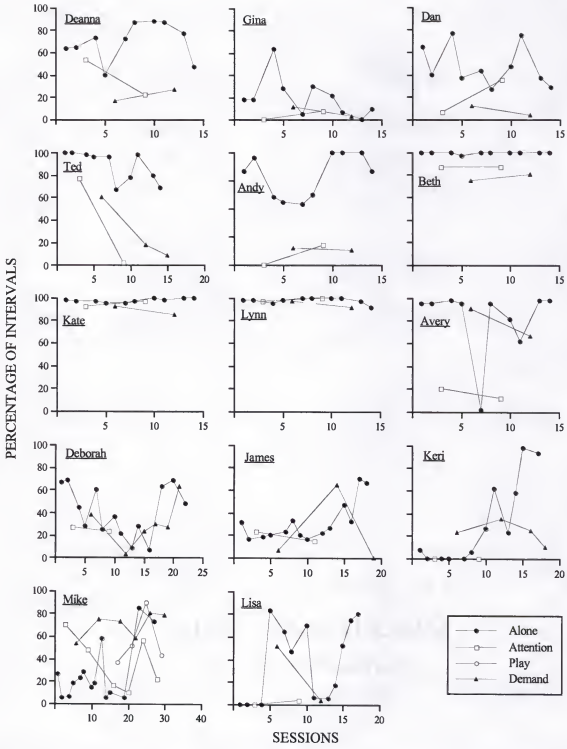

Figure 2: Percentage of intervals HM during the functional analysis from Experiment 2 for all Experiment 3 participants. See text for details.

Table 3
FA patterns for all participants during the functional analysis from Experiment 2

Participant	FA Pattern
Deanna	High in alone, lower levels in attention and demand
Gina	High in alone, lower levels in attention and demand
Dan	High in alone, lower levels in attention and demand
Ted	High in alone, lower levels in attention and demand
Andy	High in alone, lower levels in attention and demand
Beth	High in alone, lower levels in attention and demand
Kate	High and undifferentiated across all conditions
Lynn	High and undifferentiated across all conditions
Avery	High and undifferentiated across all conditions
Deborah	Extended alone and demand sessions; not differentially high in demand
James	Extended alone and demand sessions; not differentially high in demand
Keri	Extended alone and demand sessions; not differentially high in demand
Mike	Extended alone, attention, play, and demand sessions; undifferentiated across conditions
Lisa	Extended alone sessions; high in alone, lower levels in attention and demand conditions

lower levels in the attention and demand conditions. Kate and Lynn exhibited high and undifferentiated levels of responding across alone, attention, and demand conditions, whereas Avery exhibited high and undifferentiated levels of responding across alone and lower levels in the attention and demand conditions. Kate and Lynn exhibited high and undifferentiated levels of responding across alone, attention, and demand conditions, whereas Avery exhibited high and undifferentiated levels of responding across alone and attention conditions, with much lower levels in the demand condition (middle row). Deborah, James, Keri, Mike, and Lisa exhibited undifferentiated responding that was not differentially high in the alone condition, requiring a more extended analysis (bottom two rows). Deborah, James, Keri, and Lisa exhibited high levels of responding during both

alone and demand condition; thus, we extended and alternated alone and demand conditions for them. Mike exhibited high levels of HM across alone, attention, and demand conditions, and responding was not differentially high during the alone condition; thus, we conducted alone, attention, play, and demand condition in a 1:1 ratio until a clear function could be determined. All patterns indicated HM was maintained by automatic reinforcement. Table 3 shows a summary of the functional analysis patterns observed during Experiment 2 for the 14 individuals who participated in Experiment 3.

Phase II: Preference Assessments

Leisure Item Assessment

The purpose of this assessment was to identify preferred leisure items that might effectively compete with participants' HM during NCR sessions. Because all participants were exposed to the NCR treatment, all participants received a leisure item assessment. Leisure items presumed to provide different types of sensory stimulation (tactile, auditory, olfactory) were selected for use during the leisure item assessment. Item contact was defined as any contact between the participant's hand and the leisure item. Observers recorded the duration of item contact using a stopwatch, paper, and pencil. Procedures were based on those described by DeLeon, Iwata, Conners, and Wallace (1999). Ten-to-15 items were singly presented. Each item was presented for a 2-min trial, which was repeated 3 times, for a total duration of 6-min per item. Data were summarized as the total duration of item contact. Interobserver aggreement was assessed during a mean of 35.7% of the trials. Mean interobserver agreement for duration of item contact was 92.2% (range, 70.7% to 100%).

Food Item Assessment

The purpose of the food item assessment was to identify a preferred edible that might function as a reinforcer for shaping item contact during DRA sessions (see below). Five individuals who continued to engage in high levels of HM and low levels of item contact during NCR sessions (see below) received a food preference assessment before participating in the DRA intervention. The assessment procedure was similar to that described by Pace, Ivancic, Edwards, Iwata, and Page (1985). Ten edibles were presented singly three times each. Observers recorded whether or not an approach response occurred for each trial of food presentation. Approach responses were defined as the participant's placement of the edible into her/his mouth. We altered this definition slightly for individuals who could not eat independently (i.e., approach was defined as swallowing the item after it was placed in the participant's mouth). Data were summarized as percentage of approach responding by dividing the number of trials during which an approach response occurred for an item by the total number of trials during which the item was presented and multiplying by 100%. Interobserver agreement was assessed during a mean of 33.3% of the trials. Mean interobserver agreement for approach responding was 100% (range, 100% to 100%).

Results and Discussion

Results of the leisure item assessment indicated a hierarchy of preferred leisure items for 12 of the 14 participants (the remaining 2 participants interacted with all items 100% of the time). Figure 2 (top panel) shows data from Lynn's preference assessment, which are representative data of the 12 participants who exhibited differential responding during the assessment. The three items associated with the highest duration of item

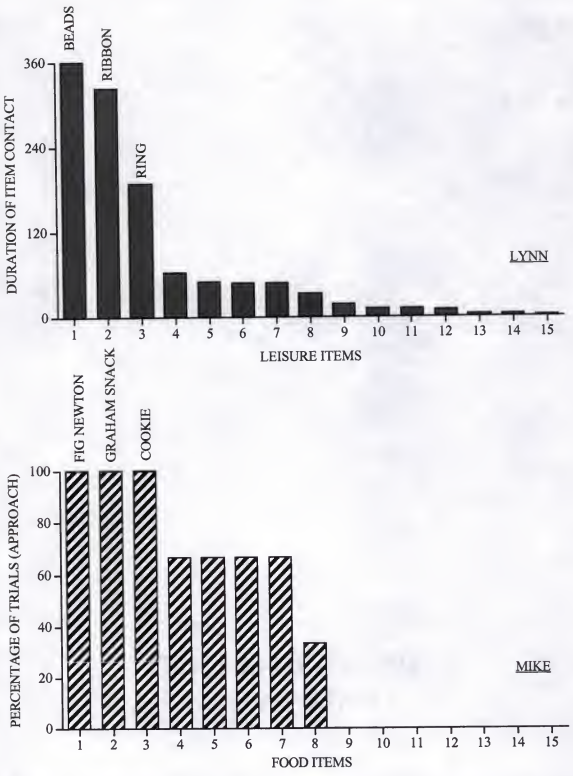

Figure 2: Duration of contact with each of the items presented during Lynn's leisure item assessment (top panel), and percentage of trials approach for each item presented during Mike's food assessment (bottom panel)

contact for Lynn were a string of beads, a ribbon, and a plastic ring. At least one of these three items was used during Lynn's NCR sessions.

Results of the food item assessment suggested several preferred food items for all participants. Data for three of the five participants indicated a hierarchy of preferred leisure items; data for the remaining two participants indicated 100% approach responding across all items. Figure 2 (bottom panel) shows Mike's data from this assessment, which are representative of those obtained for participants who exhibited differential responding during this assessment. The three edibles associated with the highest percentage of approach responding for Mike were Fig Newtons, graham crackers, and cookies. At least one of these edibles was delivered during Mike's DRA sessions.

Phase III: Treatment Evaluation

Participants and Settings

The same 14 individuals who received a functional analysis in Phase I participated in the treatment evaluation phase. Settings were identical to those of Phases 1 and 2.

Data Collection and Reliability

Data on the percentage of intervals containing HM were collected during baseline, and data on the percentage of intervals containing HM and item contact were recorded during all subsequent treatment conditions. Item contact was defined as any contact between a participant's hand and a leisure item. During sessions in which response blocking or restraint was implemented, the percentage of intervals in which HM attempts occurred was recorded. Interobserver agreement was assessed during a mean of 29.1% of the sessions. Mean interobserver agreement was 94% (range, 85% to100%) and 95.5% (range, 85.5% to100%), for hand mouthing and item contact, respectively.

Experimental Sequence and Design

All participants were exposed to baseline and one or more treatment conditions. Everyone was exposed to NCR (see below). Based on results observed during the NCR condition, treatment was complete or additional components were evaluated. The effects of interventions were evaluated in multiple baseline designs, except as noted below. All sessions were 10 min in length.

Baseline and Treatment Components

Baseline. All participants were exposed to this condition. Baseline sessions were similar to the alone condition of the functional analysis in that a therapist was present; however, no interaction or materials were delivered.

Noncontingent reinforcement (NCR). All participants were exposed to this condition. During NCR sessions, participants had continuous access to one or more of their top three preferred leisure items identified during the leisure item preference assessment. The item(s) that were used were held constant across all NCR sessions. That is, if the top preferred item was the only item used, it was the only item during all NCR sessions, and if the second most preferred item was used, this item was used during all NCR sessions. A therapist was present; however, no interaction was delivered.

Differential reinforcement of alternative behavior (DRA). Individuals who exhibited low levels of item contact during NCR sessions were exposed to this component in an attempt to increase their engagement with leisure items. In addition, one participant who exhibited high levels of item contact (and high levels of HM) was also exposed to this treatment component. During these sessions, participants had continuous access to their top preferred leisure items and were physically prompted to engage in item contact. A three-step prompting sequence (vocal, model, and physical

guidance) was initiated every 30 s, unless the participant was already engaging in item contact at the beginning of the interval. The prompting sequence began with a vocal prompt (e.g., "Play with the item"). If the participant did not begin manipulating the item within 5 s, then the therapist modeled the appropriate behavior while repeating the vocal prompt. If the participant did not engage with the item within 5 s of the model prompt, the therapist physically guided her/him to do so. Participants' most preferred food item, as identified from the food preference assessment, was delivered contingent upon item contact. The duration of item contact required for reinforcer delivery varied for each participant depending upon the mean duration exhibited during one of the NCR sessions. The specific durations required for reinforcer delivery ranged from 2-to-5 s.

Response blocking. Eight individuals whose HM occurred at high levels during the NCR condition were exposed to this treatment component in an attempt to suppress their HM. During this intervention, a therapist stood behind the participant and blocked participants' HM attempts on a fixed-ratio 1 schedule. The therapist blocked participants' hands from entering their mouths by placing the palm of the therapist's hand about 2 cm in front of the participants' mouths. HM attempts were scored each time a participant's hand contacted the back of the therapist's hand.

Brief manual restraint. One individual, Avery, whose HM was not responsive to other interventions, was exposed to brief manual restraint. During these sessions, Avery had continuous access to her top preferred leisure items. Contingent upon HM attempts, the therapist held Avery's hands in her lap for 10-s. Session time did not include time during which Avery was in brief restraint.

Results and Discussion

NCR

Figure 3 shows treatment results for Debra, Deanna, Gina, Ted, Dan, and James. During baseline, participants exhibited moderate-to-high levels of HM. During NCR, HM decreased to very low levels, and item contact occurred at very high levels for all participants. Decreases in HM and increases in item contact were immediate for all participants except Dan. Dan exhibited low-to-moderate levels of item contact during the first 2 NCR sessions; however, item contact increased to high levels during subsequent sessions. Ted and James never exhibited HM and engaged in item contact during 100% of the intervals across all NCR sessions. Six of the 14 individuals who received the NCR component were successfully treated by this intervention. The 8 individuals who were not successfully treated during NCR received one or more of the subsequent treatment components.

NCR + DRA + Response Blocking

Figure 4 shows treatment results for Andy, Keri, Beth, Mike, and Kate. During baseline, participants exhibited moderate-to-high levels of HM. During NCR, Kate's HM did not decrease and continued to occur at high levels; Beth's, Mike's, and Andy's HM decreased initially and then increased and maintained at high levels, and Keri's HM decreased and maintained at low levels. All participants except for Mike exhibited low levels of item contact during NCR sessions. In an attempt to reduce HM (for Beth, Mike, Cate, and Andy) and to increase item contact (Beth, Keri, Kate, and Andy), participants were exposed to the NCR + DRA + Response blocking intervention. During this

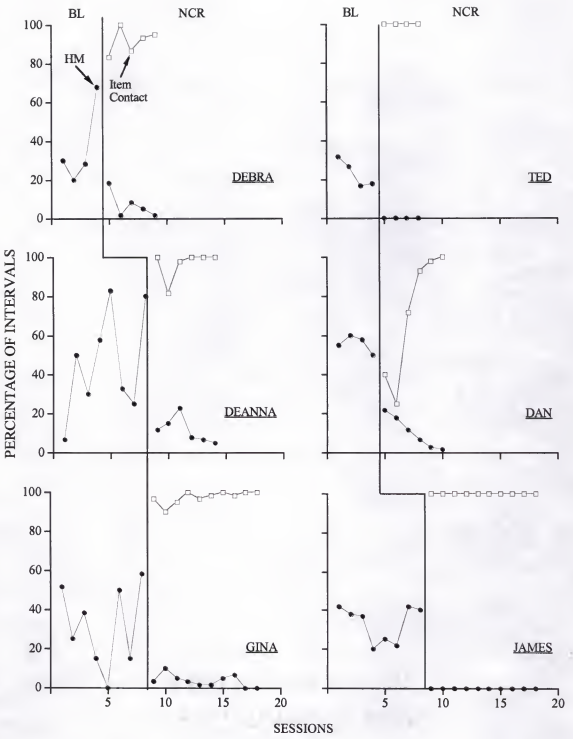

Figure 3: Percentage of intervals HM or HM and item contact during BL and NCR sessions for Debra (left top panel), Deanna (left middle panel), Gina (left bottom panel), Ted (right top panel), Dan (right middle panel), and James (right bottom panel).

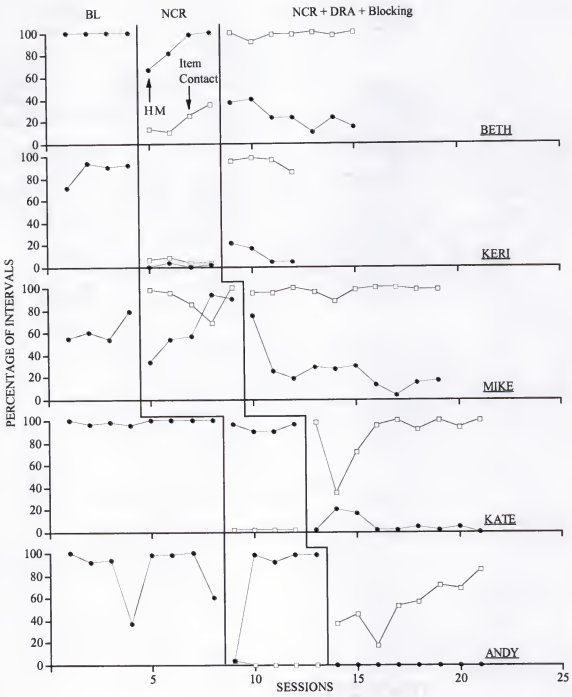

Figure 4: Percentage of intervals HM or HM and item contact during BL, NCR, and NCR + DRA + response blocking sessions for Beth (top panel), Keri (second panel), Mike (third panel), Kate (fourth panel), and Andy (bottom panel)

condition, HM decreased to much lower levels (Beth, Mike, Kate, and Andy) or continued to occur at low levels (Keri). Item contact increased for Beth, Keri, Kate, and Andy and maintained at high levels for Mike. In summary, 4 out of 7 individuals who exhibited high levels of HM during NCR received the NCR + DRA + blocking component, and all 4 were successfully treated by this intervention. Four out of 4 individuals who exhibited low levels of item contact during NCR also received the NCR + DRA + blocking component, and item contact successfully increased during this intervention. After conducting the NCR + DRA + blocking component with one participant (Mike) who exhibited high levels of item contact during NCR, we modified the treatment package by just conducting NCR + blocking for all subsequent participants exhibiting high levels of item contact during NCR (see below).

NCR + response blocking

Figure 5 shows treatment results for Lynn and Lisa. During baseline, they exhibited moderate-to-high levels of HM. During NCR, Lynn initially exhibited moderate levels of item contact; however, item contact increased to high levels across subsequent sessions. In addition, HM continued to occur at moderate-to-high levels. During NCR, Lisa immediately exhibited high levels of item contact that maintained throughout the NCR phase. Lisa's HM occurred at variable levels, often occurring at very low levels for several consecutive NCR sessions and then reemerging at very high levels. Because Lynn's and Lisa's item contact occurred at high levels during NCR, there was no need for the DRA component. Therefore, Lynn and Lisa were exposed to NCR + response blocking only. During NCR + response blocking, Lynn's HM

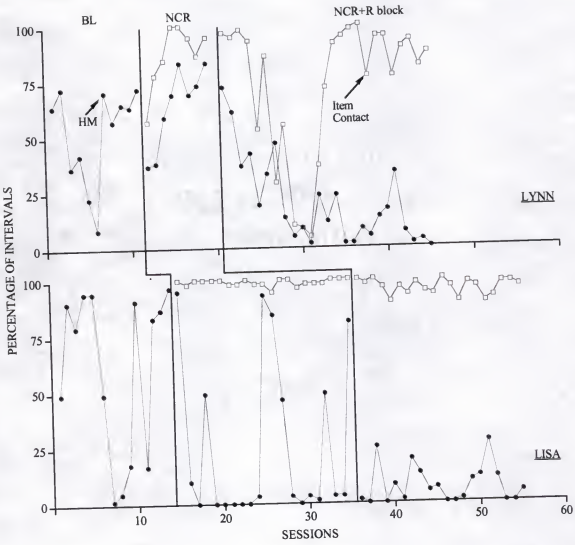

Figure 5: Percentage of intervals HM or HM and item contact during baseline, NCR, and NCR + response blocking (without DRA) for Lynn (top panel) and Lisa (bottom panel)

immediately decreased, but remained variable on several sessions until eventually reaching low levels. In addition, after the first 4 sessions, Lynn's item contact decreased to very low levels; however, during the 12th session, item contact recovered and remained high during all subsequent sessions. During NCR + response blocking, Lisa's HM decreased to lower levels with less variability than that observed during the NCR component. In addition, Lisa's item contact remained at very high levels.

NCR + brief manual restraint

Avery's results are shown in Figure 6. During baseline, Avery exhibited high levels of HM. During NCR, HM decreased but continued to occur at moderate levels, and item contact occurred at high levels. During the NCR + response blocking intervention, Avery continued to exhibit moderate levels of HM and high levels of item contact. Because NCR + response blocking did not successfully reduce Avery's HM, we assessed the effectiveness of NCR + brief manual restraint. During a return to baseline, Avery's HM returned to high levels similar to that observed during the previous BL condition. During NCR + manual restraint, HM immediately decreased to very low levels. During the 10th session of the NCR + manual restraint condition, HM increased slightly for 7 sessions and then decreased again to low levels. Item contact occurred at high levels throughout the NCR + manual restraint condition. During a second return to baseline, Avery exhibited high levels of HM. During the final NCR + restraint condition, HM immediately decreased to near-zero levels and item contact occurred at high levels. These levels of HM and item contact maintained throughout the final NCR + brief manual restraint phase.

Table 3 shows a summary of the number of participants who received each treatment component and the number who were successfully treated by that component.

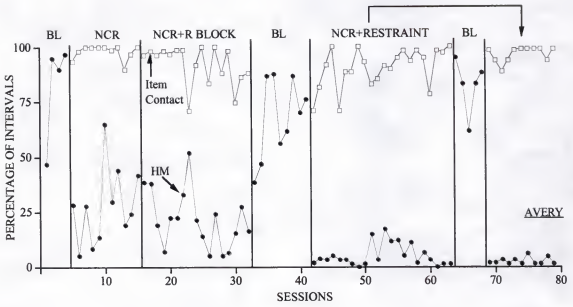

Figure 6: Percentage of intervals HM or HM and item contact during baseline, NCR, NCR + response blocking, and NCR + brief restraint conditions for Avery

NCR was implemented with all 14 participants, and 6 were successfully treated by this intervention. NCR + DRA + response blocking was implemented with 5 individuals, and all 5 were successfully treated by this intervention. NCR + response blocking (without DRA) was implemented with 3 individuals, and 2 of the 3 participants were successfully treated by this intervention. Finally, 1 individual participated in the NCR + brief restraint condition, and she was successfully treated by this intervention. In summary, the progressive series of interventions effectively reduced HM and increased item contact for all 14 participants.

Table 3: Treatment Summary

Intervention	N participated	N successful
NCR	14	6
NCR + DRA + R Block	5	5
NCR + R Block	3	2
NCR + Brief Restraint	1	1
TOTAL		14

The present findings are noteworthy for a number of reasons. First, because all participants were successfully treated with interventions consistent with a hypothesis that behavior was maintained by automatic reinforcement (i.e., none of the interventions involved manipulation of social consequences), the validity of the modified functional analysis used in this investigation was supported. Second, participants were successfully treated with various combinations of NCR, DRA, response blocking, and brief manual restraint, replicating previous research demonstrating the utility of these interventions. Third, progressively adding on different treatment components and basing treatment selection on response patterns from previous components was effective in identifying the least intrusive intervention for effectively reducing HM and/or increasing item contact for all participants. For example, response blocking + DRA was implemented with

individuals who exhibited high levels of HM and/or low levels of item contact during NCR, whereas response blocking (without the DRA component) was implemented with individuals who exhibited high levels of HM and high levels of item contact during NCR. In addition, the most intrusive intervention, brief manual restraint, was required for only one participant.

The additive treatment design used in this investigation extends that used by Lindberg et al. (1999), who progressively introduced treatment components in an additive fashion for problem behaviors maintained by automatic reinforcement. For example, they sequentially introduced NCR, prompting, DRA, response blocking, and protective equipment with two participants who exhibited stereotypy. Results indicated that response blocking or protective equipment was necessary for reducing participants' stereotypy. The present study extends that used by Lindberg et al. in two ways: (a) we implemented the treatment design with a greater number of participants and (b) we obtained successful results with each of the different treatment components used. The treatment design used in the present study also extends that used by Cooper et al. (1995), who assessed the effectiveness of various treatment components for reducing pediatric feeding problems. Cooper et al. used a similar design to that used in the present study in that they progressively altered treatment components. However, their design differed from that used in the present study in that the entire treatment package was implemented first, and, if it was found effective, selected components were progressively removed to evaluate their independent contributions. For example, during the first treatment phase, several different interventions (noncontingent access to toys and social interaction, escape extinction, praise and a sip of liquid contingent on acceptance of food) were in

effect. Next, one component (e.g., noncontingent access to toys and social interaction) was removed while the other components remained. Our design differs from that used by Cooper et al. in that we evaluated the effectiveness of a specific component initially (i.e., NCR), and, if that component was found ineffective, we progressively added more components. Both methods allow for an evaluation of specific treatment components. However, an advantage of progressively adding on treatment components rather than removing them is that if an initial component is demonstrated effective, additional interventions are unnecessary. Thus, the participant does not experience more intrusive components unless they are needed to obtain a successful outcome. The limitation of progressively adding on components is that, in the event that the initial components are ineffective, it may take longer to identify an effective treatment package.

A surprising finding was the limited effectiveness of NCR, suppressing HM in only 8 of the 14 participants (57.1%). One possible explanation for the limited effectiveness of NCR may have been the fact that several of the participants did not have item manipulation in their current repertoires. In addition, for individuals who did have item contact in their repertoires, the leisure items may not have effectively competed with the sensory stimulation produced by HM. For example, although Mike engaged in item contact during NCR, his HM did not decrease, suggesting that the stimulation produced by the leisure items did not effectively compete with Mike's HM. Future research could identify what factors were responsible for the ineffectiveness of NCR (lack of item contact in repertoire or lack of competition) by conducting NCR alone both before and after DRA. If NCR is ineffective because participants do not have item contact in their repertoire, NCR alone might maintain high levels of item contact and low levels of

problem behavior once item contact is shaped during DRA. In addition, future research is needed to determine factors that may increase the likelihood of identifying leisure items that may compete with HM. One way to increase the probability that leisure items used during NCR will compete with item contact is to measure HM during the preference assessment and only use items correlated with both high levels of item contact and low levels of HM (Roscoe, Iwata, & Goh, 1998). Another method that may used to increase the likelihood that items used during NCR will compete with HM is to identify items that produce stimulation similar to that produced by the behavior (Piazza, Adelinis, Hanely, Goh, & Delia, 2000).

The only treatment component that successfully reduced HM and/or increased item contact for all participants (N=5) was the DRA intervention. There are three possible reasons for the high degree of effectiveness of DRA in the present investigation. First, the reinforcers used during DRA were identified through a formal preference assessment. Second, item contact, when shaped, effectively competed with participants' HM. Third, DRA was always combined with response blocking, which may have contributed to the effects obtained. Future research could determine under what conditions DRA is most effective (i.e., when implemented alone or when combined with response blocking) to assess the extent to which DRA depends on being combined with response blocking.

DISCUSSION

Hand mouthing has been referred to as a form of both stereotypic and self-injurious behavior, and it has been described as behavior not maintained by social contingencies. However, the classification of hand mouthing into any one of these categories seems questionable in the absence of appropriate assessment methods. Direct observations of participants' injury associated with HM indicated that HM, when it does occur, is injurious about a third of the time. Because HM may or may not be injurious, it may be best not to refer to HM as exclusively a stereotypic or a self-injurious behavior. However, in the present study, results of functional analyses indicated that HM was overwhelmingly maintained by automatic reinforcement. Nevertheless, given that one participant's HM was maintained by social reinforcement (attention), it is important to conduct a functional analysis to definitely rule out behavioral maintenance by social contingencies. If results of the functional analysis indicate that the behavior is maintained by social contingencies, interventions found effective for behavior maintained by social reinforcement should be used.

It is unclear why such a high proportion of participants' HM was maintained by automatic reinforcement. One explanation may be that, unlike other forms of SIB that produce more immediate damage (e.g., head banging), HM may emerge initially as a fairly benign behavior. As a result, it may not produce immediate social consequences, and, as a result, may be less likely than more severe forms of SIB to acquire a social

function. Thus, when HM eventually produces injuries (and results in social consequences), these consequences do not play a role in maintenance.

In this study, a relatively efficient functional analysis, consisting primarily of alone sessions interspersed with attention and demand sessions, was developed. Only 17 of the 64 functional analyses needed to be extended before a function could be determined. Although the results from the present study provided support for the modified functional analysis design used in this investigation, future research is needed to determine the reliability and validity of these findings. For example, researchers could assess whether this functional analysis method is effective when applied to response topographies often maintained by automatic reinforcement (e.g., noninjurious stereotypic behavior).

A strength of this study was that the utility of the functional analysis design was assessed by conducting treatment procedures based on the findings obtained during the functional analysis. Given that all participants were successfully treated by interventions specifically designed for behavior maintained by automatic reinforcement, the validity of the modified functional analysis design was supported.

Because most participants' HM was maintained by automatic reinforcement, the utility of the specific functional analysis sequence that we used may not be appropriate for behavior suspected to be maintained by social contingencies. Because previous research indicated that hand mouthing is often maintained by nonsocial variables, we conducted alone sessions in a 2:1 ratio with attention and demand sessions. By contrast, for response topographies presumed to be maintained by social variables (e.g.,

aggression), a modified functional analysis consisting of mostly attention and demand sessions could be conducted with very few play and/or alone sessions.

The treatment model used during Experiment 3 demonstrated the efficacy of starting with a minimally intrusive and efficient treatment component, such as NCR, and then progressively introducing more effortful and/or intrusive interventions as needed. This model proved highly effective in that all 14 participants were successfully treated by one or more of the treatment components. In addition, brief manual restraint was required for only one participant. Future research could evaluate the effectiveness of the specific treatment sequence used in this study or other sequences that progressively introduce more restrictive interventions across other response topographies maintained by automatic reinforcement. In addition, this method of program implementation (starting with reinforcement-based interventions or interventions requiring minimal effort and gradually introducing more restrictive treatment components as needed) could also be evaluated for behavior maintained by social reinforcement.

The treatment study also extended previous research by conducting several comparative analyses. For example, the effects of NCR alone were compared with NCR + response blocking, and the effects of NCR + response blocking were compared with NCR + brief manual restraint. Because the purpose of our treatment design was to progressively introduce more intrusive interventions as needed, each component was not evaluated separately (e.g., response blocking was always combined with NCR, and DRA was always combined with response blocking). Future research is needed to determine which of the various treatment components is most effective when compared in isolation.

Future research is also needed to assess methods for promoting maintenance and generalization of interventions for HM and other topographies maintained by automatic reinforcement. Although effective interventions were identified for all 14 participants in the present study, it remains unclear if treatment effects would maintain over long periods of time. In addition, it is unclear to what extent these effects would generalize to other settings. Many of the participants in this study required the DRA + response blocking component, which was very labor intensive and may not have been practical for staff implementation for long. Although this procedure was often highly successful in producing clinically acceptable outcomes, steps should be taken to fade the amount of effort required for program implementation to a more practical level. For example, the duration of item contact required for reinforcer delivery could be gradually increased during DRA, and/or the schedule of blocking and restraint could be gradually reduced. Future research is needed to explore these and other methods for promoting generalization and maintenance of the treatment components used in this study.

REFERENCES

Ball, T. S., Campbell, R., & Barkemeyer, R. (1980). Air splints applied to control self-injurious finger sucking in profoundly retarded individuals. Journal of Behavior Therapy and Experimental Psychiatry, 11, 267-271.

Bodfish, J. W., Crawford, T. W., Powell, S. B., Parker, D. E., Golden, R. N., & Lewis, M. H. (1995). Compulsion in adults with mental retardation: Prevalence, phenomenology, and comorbidity with stereotypy and self-injury. American Journal on Mental Retardation, 100, 183-192.

Cooper, L. J., Wacker, D. P., Thursby, D., Plagmann, L. A., Harding, J., Millard, T., & Derby, M. (1992). Analysis of the effects of task preferences, task demands, and adult attention on child behavior in outpatient and classroom settings. Journal of Applied Behavior Analysis, 25, 823-840.

Cooper, L. J., Wacker, D. P., McComas, J. J., Brown, K., Peck, S. M., Richman, D., Drew, J., Frischmeyer, P., & Millard, T. (1995). Use of component analyses to identify active variables in treatment packages for children with feeding disorders. Journal of Applied Behavior Analysis, 28, 139-153.

DeLeon, I. G., Iwata, B. A., Conners, J., & Wallace, M. D. (1999). Examination of ambiguous stimulus preferences with duration-based measures. Journal of Applied Behavior Analysis, 32, 111-114.

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northup, J., Cigrand, K., & Asmus, J. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. Journal of Applied Behavior Analysis, 25, 713-721.

Dorsey, M. F., Iwata, B. A., Ong, P., & McSween, T. E. (1980). Treatment of self-injurious behavior using a water mist: Initial response suppression and generalization. Journal of Applied Behavior Analysis, 13, 343-353.

Dura, J.R., Mulick, J.A., & Rasnake, L.K. (1987). Prevalence of stereotypy among institionalized nonambulatory profoundly mentally retarded people. American Journal of Mental Deficiency, 91, 548-549.

Durand, V. M., & Crimmins, D. B. (1988). Identifying the variables maintaining self-injurious behavior. Journal of Autism and Developmental Disorders, 18, 99-117.

Favell, J. E., McGimsey, J. F., & Schell, R. M. (1982). Treatment of self-injury by providing alternate sensory activities. Analysis and Intervention in Developmental Disabilities, 2, 83-104.

Goh, H., & Iwata, B. A. (1994). Behavioral persistance and variability during extinction of self-injury maintained by escape. Journal of Applied Behavior Analysis, 27, 173-174.

Goh, H., Iwata, B. A., Shore, B. A., DeLeon, I. G., Lerman, D. C., Ulrich, S. M., & Smith, R. G. (1995). An analysis of the reinforcing properties of hand mouthing. Journal of Applied Behavior Analysis, 28, 269-283.

Griffin, J. C., Williams, D. E., Stark, M. T., Altmeyer, B. K., & Mason, M. (1986). Self-injurious behavior: A state-wide prevalence survey of the extent and circumstances. Applied Research in Mental Retardation, 7, 105-116.

Horner, R. D. (1980). The effects of an environmental "enrichment" program on the behavior of institutionalized profoundly retarded children. Journal of Applied Behavior Analysis, 13, 473-491.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994a). Toward a functional analysis of self-injury. Journal of Applied Behavior Analysis, 27, 197-209. (Reprinted from Analysis and Intervention in Developmental Disabilities, 2, 3-20, 1982)

Iwata, B. A., Pace, G. M., Dorsey, M. F., Zarcone, J. R., Vollmer, T. R., Smith, R. G., Rodgers, T. A., Lerman, D. C., Shore, B. A., Mazaleski, J. L., Goh, H., Cowdery, G. E., Kalsher, M. J., & Willis, K. D. (1994b). The functions of self-injurious behavior: An experimental-epidemiological analysis. Journal of Applied Behavior Analysis, 27, 215-240.

Kahng, S., & Iwata, B. A. (1999). Correspondence between outcomes of brief and extended functional analyses. Journal of Applied Behavior Analysis, 32, 149-159.

LaGrow, S. J., & Repp, A. C. (1984). Stereotypic responding: A review of intervention research. American Journal of Mental Deficiency, 88, 595-609.

Lerman, D. C., & Iwata, B. A. (1996). A methodology for distinguishing between extinction and punishment effects associated with response blocking. Journal of Applied Behavior Analysis, 29, 231-233.

Lindberg, J. S., Iwata, B. A., & Kahng, S. K. (1999). On the relation between object manipulation and stereotypic self-injurious behavior. Journal of Applied Behavior Analysis, 32, 51-62.

Lockwood, K., & Williams, D. E. (1994). Treatment and extended follow-up of chronic hand mouthing. Journal of Behavior Therapy and Experimental Psychiatry, 25, 161-169.

Maurice, P., & Trudel, G. (1982). Self-injurious behavior: Prevalence and relationships to environmental events. In J. H. Hollis & C. E. Meyers (Eds.), Life-threatening behavior: Analysis and intervention (pp. 81-103). Washington: American Association on Mental Deficiency.

Mazaleski, J. L., Iwata, B. A., Rodgers, T. A., Vollmer, T. R., & Zarcone, J. R. (1994). Protective equipment as treatment for stereotypic hand mouthing: Sensory extinction or punishment effects? Journal of Applied Behavior Analysis, 27, 345-355.

McClure, J. T., Moss, R. A., McPeters, J. W., & Kirkpatrick, M. A. (1986). Reduction of hand mouthing by a boy with profound mental retardation. Mental Retardation, 24, 219-222.

McGill, P., Hughes, D., Teer, K., & Rye, L. (2001). Variability in staff reports of the frequency of challenging behavior. Research in Developmental Disabilities, 22, 221-231.

Northup, J., Wacker, D., Sasso, G., Steege, M., Cigrand, K., Cook, J., & DeRaad, A. (1991). A brief functional analysis of aggressive and alternative behavior in an outclinic setting. Journal of Applied Behavior Analysis, 24, 509-522.

Pace, G. M., Ivancic, M. T., Edwards, G. L., Iwata, B. A., & Page, T. J. (1985). Assessment of stimulus preference and reinforcer value with profoundly retarded individuals. Journal of Applied Behavior Analysis, 18, 249-255.

Paisey, T. J. H., Whitney, R. B., & Wainczak, S. M. (1993). Case study: Noninvasive behavioral treatment of self-injurious hand stereotypy in a child with Rett syndrome. Behavioral Residential Treatment, 8, 133-145.

Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. Journal of Applied Behavior Analysis, 33, 13-27.

Rast, J., & Jack, S. (1992). Mouthing. In E.A. Konarski, J.E. Favell (Eds.), Manual for the assessment and treatment of the behavior disorders of people with mental retardation (pp. 1-11). Morganton, NC: Western Carolina Center Foundation.

Repp, A. C., Singh, N. N., Olinger, E., & Olson, D. R. (1990). The use of functional analyses to test causes of self-injurious behavior: Rationale, current status, and future directions. Journal of Mental Deficiency Research, 34, 95-105.

Ringdahl, J. E., Vollmer, T. R., Marcus, B. A., & Roane, H. S. (1997). An analogue evaluation of enviornmental enrichment: The role of stimulus preference. Journal of Applied Behavior Analysis, 30, 203-216.

Rojahn, J. (1986). Self-injurious and stereotypic behavior of noninstitutionalized mentally retarded people: Prevalence and classification. American Journal of Mental Deficiency, 91, 268-276.

Roscoe, E. M., Iwata, B. A., & Goh, H. (1998). A comparison of noncontingent reinforcement and sensory extinction as treatments for self-injurious behavior. Journal of Applied Behavior Analysis, 31, 635-646.

Schroeder, S. R., Schroeder, C. S., Smith, B., & Dalldorf, J. (1978). Prevalence of self-injurious behaviors in a large state facility for the retarded: A three year follow-up study. Journal of Autism and Childhood Schizophrenia, 8, 261-269.

Shore, B. A., Iwata, B. A., DeLeon, I. G., Kahng, S., & Smith, R. G. (1997). An analysis of reinforcer substitutability using object manipulation and self-injury as competing responses. Journal of Applied Behavior Analysis, 30, 21-41.

Singh, N. N., & Millichamp, C. J. (1987). Independent and social play among profoundly mentally retarded adults: Training, generalization, and long-term follow-up. Journal of Applied Behavior Analysis, 20, 23-34.

Thompson, R. H., Iwata, B. A., Conners, J., & Roscoe, E. M. (1999). Effects of reinforcement for alternative behavior during punishment of self-injury. Journal of Applied Behavior Analysis, 32, 317-328.

Troster, H., Brambring, M., & Beelmann, A. (1991). Prevalence and situational causes of stereotyped behaviors in blind infants and preschoolers. Journal of Abnormal Child Psychology, 19, 569-590

Turner, W. D., Realon, R. E., Irvin, D., & Robinson, E. (1996). The effects of implementing program consequences with a group of individuals who engaged in sensory maintained hand mouthing. Research in Developmental Disabilities, 17, 311-330.

Vaughan, M. E. & Michael, J. L. (1982). Automatic reinforcement: An important but ignored concept. Behaviorism, 10, 217-228.

Vollmer, T. R., Marcus, B. A., & LeBlanc, L. (1994). Treatment of self-injury and hand mouthing following inconclusive functional analyses. Journal of Applied Behavior Analysis, 27, 331-344.

Vollmer, T. R., Marcus, B. A., Ringdahl, J. E., & Roane, H. S. (1995). Progressing from brief assessments to extended experimental analyses in the evaluation of aberrant behavior. Journal of Applied Behavior Analysis, 28, 561-576.

Wacker, D., Steege, M., Northup, J., Reimers, T., Berg, W., & Sasso, G. (1990). Use of functional analysis and acceptability measures to assess and treat severe behavior problems: An outpatient clinic model. In A. C. Repp & N. N. Singh (Eds.), Perspectives on the use of nonaversive and aversive interventions for persons with developmental disabilities (pp. 349-359). Sycamore, IL: Sycamore Publishing Co.

Wallace, M. D., & Iwata, B. A. (1999). Effects of session duration on functional analysis outcomes. Journal of Applied Behavior Analysis, 32, 175-183.

BIOGRAPHICAL SKETCH

Eileen Roscoe was born in Miami, FL. She entered the University of Florida in 1992 and graduated in 1996 with a degree in psychology. During her undergraduate studies, she enrolled in the applied behavior analysis lab and gained her first exposure to behavior analysis and individuals diagnosed with developmental disabilities. Following this, she served as a volunteer at the Florida Center on Self-Injury, where she gained experience conducting assessments and treatments of severe behavior disorders. Her experience at the Florida Center on Self-Injury led her to seek graduate training in the field of behavior analysis. In the Fall of 1996, she enrolled in the behavior analysis program at the University of Florida to pursue a doctoral degree in psychology. She worked as a graduate research assistant at the Florida Center on Self-Injury from 1996 to 2001 under the direction of Dr. Brian Iwata. Expecting graduation in August, 2001, Eileen has accepted an appointment as a post-doctoral fellow at the Marcus Institute, a hospital located in Atlanta, GA, and affiliated with Emory University. She plans to further her career in applied behavior analysis by conducting clinical work and research in the application of behavioral principles to the treatment of behavior disorders.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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